Master of Science in Biotechnology
Program code: 049050

INTRODUCTION

The Department of Biological Sciences (College of Science) offers a Master of Science program in **Biotechnology** thesis option only. Both part-time and full-time students are admitted to this program. The program will involve interdisciplinary training with both theory and practical experience in biotechnology, genomics, bioinformatics, biomedical engineering, plant and animal biotechnology and stem cell technology as well as biological patency, commercialization and regulation.

According to the University Council decision dated 4/2/2007, Thesis students admitted with effect from September 2007 are exempted from the comprehensive examination.

PROGRAM REQUIREMENTS

33 (33) TOTAL COURSE CREDITS

18 (21) COMPULSORY COURSES

0480-585	Statistical Methods in Research	(3)
0497-501	Molecular Biotechnology	(3)
0497-503	Techniques in Biotechnology	(3)
0497-506	Biotechnology Regulations and Commercialization Equivalent to 0497-504	(3)
0497-509	Bioinformatics	(3)
0497-593	Project	(3)
2000-501	Scientific Writing & Communication Skills Equivalent to 0497-510 \ 0497-520	(3)

6 (12) ELECTIVE COURSES*

0494-543	Plant Biotechnology	(3)
0497-505	Developmental Genetics and Biology	(3)
0497-507	Animal Biotechnology	(3)
0497-511	Advanced Techniques in Genomics & Proteomics	(3)
0497-513	Biotechnology and the Environment	(3)
0497-515	Stem Biology and Tissue Engineering	(3)
0497-525	Biosensers	(3)
2050-514	Molecular Microbiology	(3)
2050-526	Advanced Biotechnology	(3)

*The program students are allowed to take a total of not more than 6 credits from any 500 level courses offered by other graduate programs in the College of Graduate Studies. Only 3 credits are be allowed to be taken from 400-level courses offered in the College of Science with the approval of the Program Director.

9 COMPULSORY COURSES

0497-597	Thesis	(0)
0497-598	Thesis	(0)
2000-599	Thesis	(9)

COURSE DESCRIPTION

0497-501: MOLECULAR BIOTECHNOLOGY
CR: 3

This course will review general topics in the area of molecular biotechnology with emphasis on theory and applications. It will include topics such as recent advances and innovative discoveries of tools and techniques; manipulation of different organisms including microorganisms, plants and animals; various aspects of biotechnology applications including agriculture, animal breeding, gene therapy, cell replacement therapy, industrial and environmental biotechnology as well as nanobiotechnology.

0497-503: TECHNIQUES IN BIOTECHNOLOGY
CR: 2

This course is lab based (practicals and lab rotations) and involves several topics in molecular biotechnology methods including both nucleic acid and protein analysis in various areas of biotechnology. Topics and laboratory activities include nucleic acid purification and analysis, gene cloning, protein expression, purification and engineering, biomanufacturing, the detection of Genetically Modified Organisms (GMO). These topics will provide hands on experience with PCR, RT-PCR, sequencing, Clone library construction, bacterial transformation, selection and clone verification using restriction enzyme analysis, protein expression as well as introduction of DNA into animal and plant cells. Moreover, there will be experiments on induction using fermentation, cation exchange and heparin-sepharose FPLC column chromatography and other biotechniques such as ELISA. The course will train students in how to conduct a scientific research project, troubleshooting, data analysis and scientific presentations both written and oral.

0497-505: DEVELOPMENTAL GENETICS AND BIOLOGY
CR: 3

This course will cover principles of developmental genetics, developmental biology in both animals and plants and their importance in biotechnology. The course will cover practical aspects of biotechnology techniques in plant and animal breeding including transgenic models, genetic and embryology techniques used in developmental genetics as well as stem cell research and applications. It will also describe current approaches in the study of gene expression, over-expression and knock-out models with their relevance to development.

0497-506: BIOTECHNOLOGY REGULATIONS AND COMMERCIALIZATION
CR: 3

This course deals with policies that govern the use of biotechnology. Topics covered include laws and regulations of scientific research and applications of genetic engineering, cloning and DNA finger printing etc. Copyrights and patency and consumer rights will be reviewed as well. Topics also includes individual and governmental responsibility in implementing rules and regulations that promote the ethical and legal use of biotechnology tools while preventing abuses to natural resources and harm to biological and genetic diversity. The course will also cover

principles of marketing and commercialization of bio-products. Topics include survey and assessment of market needs, performing feasibility studies, cost and evaluation of biotechnology products, production trials, marketing and management, technology transfer and product diversity and next generation development. The course will also include study examples of bio-products commercialization in pharmaceuticals, food production, biofuels and bioremediation.

0497-507: ANIMAL BIOTECHNOLOGY
CR: 3

This course will cover the latest advances in both theory and practice of animal biotechnology and its applications in research, industry, and disease diagnosis and therapy. It will provide an advanced theoretical background with a strong practical emphasis on various topics including basic cell culture techniques, transgenic animals, gene knockouts, stem cell biology, pharmacogenomics, fluorescent microscopy, microarray analysis, as well as RNA and protein expression of selected genes. The biotechnology concepts that will be learned in the lectures will be reinforced by hands-on laboratory project and laboratory rotations. The course will include practical exercises to train students in how to conduct a scientific research project, troubleshooting, data analysis and scientific presentations both written and oral.

0497-509: BIOINFORMATICS
CR: 3

This course will include theory, practicals, and case studies to cover an introduction to and basic concepts in Bioinformatics and computational biology tools such as data mining, statistical analysis and algorithmic techniques. It will also examine various applications of bioinformatics to biological processes as well as data acquisition and sequence analysis, sequence comparison and alignment, and bioinformatics modelling tools. There will be hands-on practice of online tools (BLAST, ClustalW, HADDOCK) and resources for nucleic acid and protein sequence databases (TrEMBL, RefSeq, UniProt), distance-based phylogenies, and database design. In addition, the principles and application of programming languages in Bioinformatics (Perl), including web server programming, will be covered. Sources of noise and biases in various types of biological network data will be reviewed along with network models, growth models and network motifs.

0497-511: ADVANCED TECHNIQUES IN GENOMICS & PROTEOMICS
CR: 2

This course will cover advanced techniques in genomics such as DNA Microarrays (objectives and classes of Microarrayes: Custom/spotted microarray), High-Density oligonucleotide arrays, and Long nucleotide arrays. It will also review genome sequencing including Next- Generation sequencing methods, technology, instrumentation involved and bases of differences. The course will also introduce general concepts in proteomics and examine proteomics techniques such as protein separation, two-dimensional gel electrophoresis and detection techniques, and chromatographic techniques. The course will also cover protein and peptide identification by peptide fingerpriniting, amino acid sequence analysis. Experimental design and bioinformatics analysis as well as principle of Mass Spectrometry and uses for protein identification will be reviewed. Other topics that will be covered include protein arrays design and application, functional proteomics techniques including protein profiling and data analysis and interpretation. Practical exercises will be included in this course.

0497-513: BIOTECHNOLOGY AND THE ENVIRONMENT
CR: 3

This course will give a general back ground on environmental biotechnology. The course will include topics on: ecological systems, types of environment pollutants and their effect on living organisms and ecological systems, using plants and microbial biotechnology for detection of pollutants, production of biodegradable bio-products, bioremediation of contaminated soil and water, biofuels and renewable energy, potential environmental hazards of genetically modified organisms (GMOs), biotechnology in environment management and ethics. The practical part will provide training on identification, detection and measurement of environmental pollutants, investigating the effect of pollutants on living organisms, bioremediation and production of bio-fuels.

0497-515: STEM CELL BIOLOGY AND TISSUE ENGINEERING
CR: 4

This course will explain how artificial tissue can be created in the lab for subsequent transplantation. It will describe different cell sources used in tissue

engineering including embryonic stem cells, cloning procedures, induced pluripotent stem cells (iPS cells), adult stem cells and list different biomaterials used in this technology. The use of specialized cell culture systems that direct the growth and differentiation into different tissue types will be covered (e.g. liver, blood vessels, bone, cartilage and skin); along with how microenvironment features can be manipulated to optimize tissue growth. It will also examine how cells and biomaterials can be combined to form a three dimensional tissue organization. Finally, the challenges of tissue integration into living systems will be discussed. The module will provide an overview and some practical exercises of how stem cells can be differentiated and utilized in biotechnologies, particularly for therapeutic purposes and in drug screening/discovery. Practical examples of tissue engineering using different biomaterials will also be demonstrated, plus potential uses of tissue engineering in diagnostics and research.

0497-525: BIOSENSERS
CR: 3

The biosensor (or biological sensor) course covers the principles, technologies, methods and applications of biosensors and bioinstrumentation. The objective of this course is to link engineering principles to understanding of biosystems in sensors and bioelectronics. It will provide the student with detail of methods and procedures used in the design, fabrication and application of biosensors and bioelectronic devices. The fundamentals of measurement science are applied to optical, electrochemical, mass, and pressure signal transduction. Upon successful completion of this course, student will have a full knowledge of the range of biosensor types and designs, the principle ways in which they can be interrogated, and an understanding of their current and potential applications. Students will also be able to extend principles of engineering to the development of bioanalytical devices and the design of biosensors. The student also will understand the principles of linking cell components and biological pathways with energy transduction, sensing and detection.

0497-597: THESIS
CR: 0

0497-598: THESIS
CR: 0

2000-599: THESIS
CR: 9